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# Effect of packing materials and storage period on germination and seedling growth of mustard (*Brassica juncea*)

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ABSTRACT

A study was conducted during 2004–09 to study the storability of Indian mustard (*Brassica juncea* L. Czern & Coss.) seed to prolong seed viability and seedling vigoyur index. Seeds of mustard varieties, 'GM 1' and 'GM 2' produced during winter (*rabi*) season 2003–04 were stored in six different packing materials, ie seed packed in polyethylene bag, seeds packed in cloth bag, seed packed in paper bag, seed kept in iron bin, seed kept in iron bin and sealed with cellophane tape and seed kept in iron bin with 1% $CaCl_2$ and sealed with cellophane tape. Seed germination percentage, root length, shoot length and seedling vigour were studied. In the fifth year the highest mean values of germination percentage (60.40), root length (8.55 cm), shoot length (6.09 cm) and seedling vigour index (966.85) were recorded in seed stored in iron bin with $CaCl_2$ (1%) and sealed with cellophane tape ($P_6$), followed by seed packed in polyethylene bag ($P_1$). The Indian mustard variety 'GM 1' exhibited better storability capability than 'GM 2'.

**Key words**: Calcium Chloride, Germination per cent, Indian Mustard, Packing material, Seedling vigour index

Indian mustard *[Brassica juncea* (L) Czern & Coss] is an important oilseed crops in India occupying 68.50 lakh ha area with annual production of 83.60 lakh tonns. North Gujarat is ideally suited for its cultivation, having 3.38 lakh ha area with 4.56 lakh tonnes of production and 1349 kg/ha productivity (DOA 2007–08), which is highest in the country.

The productivity of mustard in the state can be further increased through the adoption of improved technology. Among the various technology components the adoption of improved genotypes in Gujarat has enhanced the production up to 7% with an additional returns of ₹ 1 837/ha (DOR 2009).

The good quality seed play important role in enhancing crop productivity, which is universally acknowledged. It is also well recognized that maintenance of seed vigour during storage is most important to maintain viability of seeds. Identification / development of suitable packaging materials and storage condition needs to be investigated to increase seed replacement rate which is presently 23% in the state. The enhanced seed replacement rate of mustard will definitely increase productivity of mustard in the state.

Thus the present investigation was under taken to prolong the seed viability and vigour under ambient conditions by using different packaging materials and predominated superior mustard genotypes 'GM 1'(Gujarat Mustard 1) and 'GM 2' (Gujarat Mustard 2).

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## MATERIALS AND METHODS

Seeds of mustard varieties 'GM 1' and 'GM 2' produced during winter (*rabi*) 2003–04 were sun-dried to maintain the moisture content to less than 10%. Well-dried seeds (1.0 kg) were stored in different containers, viz seed packed in polyethylene bag ($P_1$), seed packed in cloth bag ($P_2$), seed packed in paper bag ($P_3$), seed kept in iron bin ($P_4$), seed kept in iron bin and sealed with cellophane tape ($P_5$) and seed kept in iron bin with $CaCl_2$ (1%) and sealed with cellophane tape ($P_6$). The seed containers were stored at room temperature during storage period.

Storage seeds were drawn in first, second, third, fourth and fifth year from the respective containers for quality test, viz standard seed germination per cent, root length, shoot length and seedling vigour index as per the standard procedure of International Seed Testing Association (ISTA 1999). In laboratory condition seed germination test was conducted in Petri-dish and maintained under controlled environmental conditions, ie 25°C temperature and 70 (%) relative humidity during laboratory experiment. The germination per cent and other observations like root and shoot length were recorded after seven days of sowing. Seedling vigour index was computed by multiplying seedling length and seed germination (%). Data were subjected to

statistical analysis using factorial complete randomized design as per standard procedure.

## RESULTS AND DISCUSSION

The analysis of variance indicated presence of genotypic variability for seed germination (%) in all the years of experimentation. The difference among packing materials were non-significant in first year, indicating absence of effect on germination per cent by packaging material. However, results indicated that germination percentage, shoot length, root length and seedling vigour index (SVI) in the 4–5th year stored mustard seeds were significantly influenced due to different packing materials, genotypes as well as their interactions.

Seed stored in iron bin containing $CaCl_2$ (1%) and sealed with cellophane tape ($P_6$) recorded highest value of seed germination (%) (60.89), followed by seed kept in polyethylene bag (Table 1).

The vigour and viability of seed to a great extent depends on the storability, which is determined by moisture (%) of seed, relative humidity (%) and temperature. High content of seed moisture and relative humidity are congenial for seed

Table 1 Mean values of seed germination (%), as affected by Indian mustard genotypes and different packing materials at seeding stage under laboratory conditions

| Packing materials/ varieties | Germination (%) | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003–04 | | 2004–05 | | 2005–06 | | 2006–07 | | 2007–08 | | |
| | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | |
| $P_1$ | 96.00 | 95.50 | 88.00 | 84.00 | 71.33 | 56.67 | 31.67 | 24.33 | 22.67 | 9.67 | 57.98 |
| $P_2$ | 98.00 | 96.00 | 88.00 | 84.00 | 74.00 | 68.00 | 25.67 | 25.33 | 0.00 | 0.00 | 55.90 |
| $P_3$ | 99.00 | 95.00 | 88.00 | 84.70 | 68.00 | 48.67 | 8.67 | 11.33 | 0.00 | 0.00 | 50.34 |
| $P_4$ | 99.00 | 92.50 | 93.50 | 81.25 | 54.67 | 45.33 | 0.00 | 0.00 | 0.00 | 0.00 | 46.63 |
| $P_5$ | 97.00 | 94.00 | 93.50 | 84.75 | 76.67 | 68.67 | 30.33 | 0.00 | 0.00 | 0.00 | 54.49 |
| $P_6$ | 97.75 | 93.80 | 90.00 | 81.00 | 75.33 | 70.67 | 32.67 | 27.33 | 20.67 | 11.67 | 60.09 |
| Mean | 97.90 | 94.50 | 90.17 | 83.29 | 72.00 | 56.78 | 21.5 | 14.7 | 7.22 | 3.6 | 54.17 |
| per cent reduction over years | | | | 7.90 | 11.86 | 20.15 | 31.83 | 70.14 | 74.11 | 66.42 | 75.51 |

| | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SE±m | 0.47 | 0.82 | 1.26 | 0.34 | 0.58 | 0.83 | 1.84 | 3.19 | 4.51 | 0.13 | 0.08 | 0.18 | 0.26 | 0.45 | 0.63 |
| CD (*P*=0.05) | 1.58 | NS | NS | 0.97 | 1.68 | 2.37 | 5.40 | 9.35 | 13.23 | 0.39 | 0.22 | 0.54 | 0.76 | 1.31 | 1.86 |
| CV (%) | | 2.42 | | | 1.91 | | | 12.08 | | | 17.08 | | | 20.33 | |

$P_1$, Seed packed in polyethylene bag; $P_3$, seed packed in cloth paper bag; $P_5$, seed kept in iron bin and sealed with cellophane tape
$P_2$, seed packed in cloth bag; $P_4$, seed kept in iron bin; $P_6$, seed kept in iron bin with $CaCl_2$ (1%) and sealed with cellophane tape
V, varieties P, packing materials

Table 2 Mean values of root lengths as affected by Indian mustard genotypes and different packing materials at seeding stage under laboratory conditions

| Packing materials/ varieties | Root length (cm) | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003–04 | | 2004–05 | | 2005–06 | | 2006–07 | | 2007–08 | | |
| | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | |
| $P_1$ | 11.15 | 13.04 | 16.74 | 19.45 | 3.73 | 3.10 | 2.30 | 2.00 | 6.23 | 5.88 | 8.36 |
| $P_2$ | 11.10 | 13.37 | 18.74 | 17.89 | 4.23 | 2.71 | 1.40 | 2.40 | 0.00 | 0.00 | 7.18 |
| $P_3$ | 10.86 | 11.98 | 19.29 | 20.31 | 2.24 | 2.05 | 1.10 | 1.40 | 0.00 | 0.00 | 6.92 |
| $P_4$ | 11.62 | 13.39 | 19.38 | 15.40 | 2.50 | 2.18 | 0.00 | 0.00 | 0.00 | 0.00 | 6.45 |
| $P_5$ | 12.15 | 14.49 | 17.61 | 16.10 | 2.59 | 3.59 | 2.40 | 0.00 | 0.00 | 0.00 | 6.89 |
| $P_6$ | 12.28 | 14.33 | 18.44 | 16.32 | 2.88 | 2.88 | 3.50 | 2.90 | 4.78 | 7.27 | 8.56 |
| Mean | 11.53 | 13.43 | 18.37 | 17.58 | 2.85 | 2.75 | 1.80 | 1.50 | 1.83 | 2.19 | 5.55 |

| | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SE ±m | 0.13 | 0.23 | 0.33 | 0.17 | 0.29 | 0.42 | 0.07 | 0.12 | 0.17 | 0.09 | 0.15 | 0.17 | 0.09 | 0.16 | 0.22 |
| CD (*P*=0.05) | 0.44 | 0.76 | NS | 0.49 | 0.84 | 1.19 | 0.21 | 0.36 | 0.51 | NS | 0.46 | 0.51 | NS | 0.47 | 0.65 |
| CV (%) | | 5.27 | | | 4.63 | | | 10.73 | | | 23.67 | | | 19.10 | |

metabolic rates as well as to grow fungus even at room temperature. Mustard being an oilseed crops and hygroscopic, it absorb moisture from surrounding storage environment and lose viability rapidly. But desiccators like $CaCl_2$ as in present investigation exhibited higher viability of seed in air-tight container. The results were in agreement with earlier findings of Nautiyal and Ravindra (1996), Tripathi *et al.*(1996) and Sinha *et al.* (1997) in groundnut, Singh *et al.* (2001) in soybean, Padma and Reddy (2000) in onion and Mettenada (2005) in rice. Therefore, it is necessary to use impervious containers to slow down the seed viability deterioration under storage.

Indian mustard variety 'GM 1' stored in different packing materials maintains required standard of germination up to two years. Whereas, variety 'GM 2' failed to maintain required germination standard except seed stored in iron bin sealed with cellophane tape ($P_5$). It indicates higher genotypic potential of 'GM 1' in maintaining viability of seed. The highest root length value (8.56 cm) was observed by seed stored in iron bin with $CaCl_2$ (1%) and sealed with cellophane tape ($P_6$) over the rest of packing materials (Table 2).

Among the different packing materials, seed stored in iron bin containing $CaCl_2$ (1%) and sealed with cellophane tape ($P_6$) also showed superiority for the value of shoot length and seedling vigour index as compared to other packing materials (Tables 3,4). The variety 'GM 1' recorded higher

Table 3 Mean value of shoot lengths as affected by Indian mustard genotypes and different packing materials at seeding stage under laboratory conditions

| Packing materials/ varieties | Shoot length (cm) | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003–04 | | 2004–05 | | 2005–06 | | 2006–07 | | 2007–08 | | |
| | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | |
| $P_1$ | 6.01 | 6.55 | 6.38 | 6.52 | 3.75 | 3.31 | 3.33 | 2.87 | 5.88 | 12.11 | 5.67 |
| $P_2$ | 5.77 | 6.11 | 6.34 | 6.76 | 3.95 | 3.82 | 2.20 | 3.00 | 0.00 | 0.00 | 3.80 |
| $P_3$ | 5.55 | 5.74 | 6.60 | 6.99 | 3.56 | 3.35 | 1.40 | 1.40 | 0.00 | 0.00 | 3.46 |
| $P_4$ | 6.92 | 6.83 | 7.40 | 8.41 | 3.43 | 3.05 | 0.00 | 0.00 | 0.00 | 0.00 | 3.60 |
| $P_5$ | 6.31 | 6.46 | 7.39 | 8.09 | 3.58 | 4.31 | 2.50 | 0.00 | 0.00 | 0.00 | 3.86 |
| $P_6$ | 6.68 | 6.51 | 7.24 | 7.97 | 3.69 | 4.00 | 2.80 | 2.70 | 7.27 | 12.05 | 6.09 |
| Mean | 6.21 | 6.37 | 6.89 | 7.46 | 3.65 | 2.85 | 2.00 | 1.70 | 2.19 | 4.03 | 4.34 |
| | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P | |
| SE±m | 0.08 | 0.13 | 0.19 | 0.07 | 0.13 | 0.18 | 0.06 | 0.11 | 0.16 | 0.08 | 0.13 | 0.18 | 0.04 | 0.07 | 0.09 | |
| CD (*P*=0.05) | NS | 0.43 | NS | 0.21 | 0.36 | 0.58 | 0.19 | 0.33 | 0.46 | NS | 0.38 | 0.54 | 0.11 | 0.19 | 0.27 | |
| CV (%) | | 5.68 | | | 4.98 | | | 7.52 | | | 17.08 | | | 19.10 | | |

Table 4 Mean values of seed vigour index (SVI) as affected by Indian mustard genotypes and different packing materials at seeding stage under laboratory conditions

| Packing materials/ varieties | Seedling vigour | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003–04 | | 2004–05 | | 2005–06 | | 2006–07 | | 2007–08 | | |
| | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | 'GM 1' | 'GM 2' | |
| $P_1$ | 1647.0 | 1871.0 | 2034.0 | 2182.0 | 531.9 | 361.7 | 175.0 | 117.8 | 171.0 | 91.4 | 918.3 |
| $P_2$ | 1653.0 | 1871.0 | 2206.0 | 2017.0 | 588.4 | 442.5 | 92.9 | 142.0 | 0.0 | 0.0 | 901.3 |
| $P_3$ | 1624.0 | 1684.0 | 2277.0 | 2314.0 | 395.2 | 256.8 | 21.4 | 31.4 | 0.0 | 0.0 | 860.4 |
| $P_4$ | 1835.0 | 1870.0 | 2503.0 | 1935.0 | 324.0 | 238.0 | 0.0 | 0.0 | 0.0 | 0.0 | 870.5 |
| $P_5$ | 1808.0 | 1968.0 | 2337.0 | 2050.0 | 472.8 | 542.3 | 150.3 | 0.0 | 0.0 | 0.0 | 932.8 |
| $P_6$ | 1849.0 | 1953.0 | 2310.0 | 1968.0 | 494.3 | 485.8 | 201.0 | 154.0 | 138.4 | 115.0 | 966.9 |
| Mean | 1736.0 | 1869.0 | 2278.0 | 2086.0 | 467.8 | 387.8 | 106.8 | 74.2 | 51.6 | 34.4 | 909.2 |
| | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P | V | P | V×P | |
| SE±m | 17.2 | 29.8 | 42.2 | 18.1 | 31.3 | 44.2 | 10.7 | 18.5 | 26.1 | 3.9 | 6.7 | 9.5 | 1.8 | 3.0 | 4.3 | |
| CD (*P*=0.05) | 56.0 | 96.9 | NS | 51.8 | 89.7 | 126.8 | 31.3 | 54.2 | 76.6 | NS | 19.7 | 27.8 | 5.1 | 8.8 | 12.5 | |
| CV (%) | 4.7 | 4.05 | 10.6 | 18.4 | 17.4 | | | | | | | | | | | |

value of germination percentage and seedling vigour index than 'GM 2'. It has been observed that lipoxygenase enzymes generate free radicals, as the seed moisture increase, are responsible for chromosomal abnormalities which adversely affect the germination. As seeds aged, the propensity of genetic mutations increases. Many of these mutations can be detected as chromosal aberrations (Ghosal and Mondal 1978, Murata *et al.* 1981). These chromosomal aberrations delay seedling growth and results in fewer normal cells, with these chromosomal irregularities etc. Such mutants are not able to compete with normal ones and adversely affect seed germination etc. ((Murata *et a*l. 1984). Channakeshava *et al.* (2001) in maize, also reported similar trend for seedling vigour.

Based on present findings it is concluded that mustard seed can be stored in iron bin containing $CaCl_2$ (1%) and sealed with cellophane tape up to three years. The mustard variety 'GM 1' can be stored for three years without much reduction in germination percentage. Farmers can use these packing materials for keeping own produced seed. Recommendation will be useful for enhancing seed replacement rate and higher productivity of mustard.

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